PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2003-185990
(43)Date of publication of application : 03.07.2003

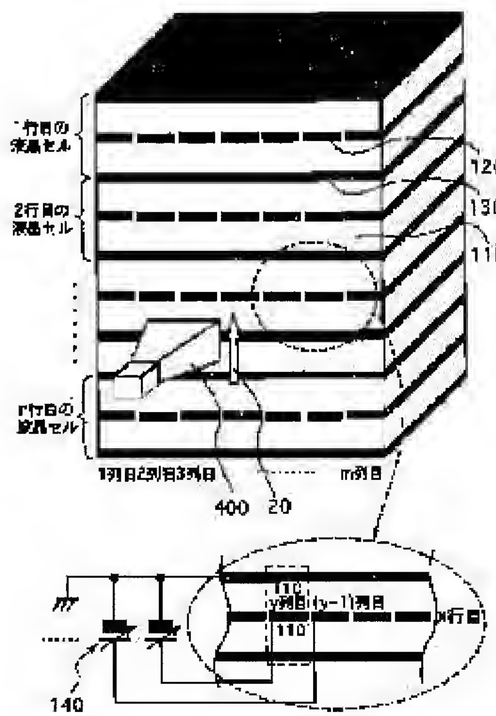
(51)Int.Cl. G02F 1/13
H01Q 3/46
H01Q 15/02

(21)Application number : 2001-389910
(22)Date of filing : 21.12.2001

(71)Applicant : NIPPON HOSO KYOKAI <NHK>
(72)Inventor : KUKI TAKAO
NOMOTO TOSHIHIRO

(54) LENS ANTENNA

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a lens antenna capable of improving the transmittance of incident radio waves, extending the control range of the progressing direction of radio beams and improving the response speed in the control of the radio beams.
SOLUTION: The lens antenna has a plurality of laminar members having two planar liquid-impregnated blanks 110 obtained by impregnating prescribed planer blanks, such as paper, cloth or fibers, with the prescribed liquid crystals having the high anisotropy of a dielectric constant, first planar electrodes 120 disposed to be held between the two blanks 110, and second planar electrodes 130 disposed on any one surface among the surfaces of the blanks 110 facing the surfaces holding the electrodes 120 therebetween. The respective laminar members are stacked in such a manner that the electrodes of the second planar electrodes disposed at the respective laminar members do not overlap one another.



DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]This invention relates to the lens antenna for controlling the direction of movement of an electric wave electronically based on the signal inputted from the outside.
[0002]
[Description of the Prior Art]Conventionally, it is indicated by JP,3-6683,B and the lens antenna 300 of composition as shown in drawing 3 is known. A liquid crystal is used for the lens antenna 300 of composition of having been shown in drawing 3 as a medium used in order to make the direction of movement of an electric wave change. Here, the lens antenna 300 is constituted by two or more phase converters 310 as shown in drawing 3 (a). In drawing 3 (a), an electric wave is emitted towards the lens antenna 300 from the horn antenna 400, and the electric field of the electric wave emitted assumes that it is suitable in the direction 20.
[0003]Drawing 3 (b) is a partially broken figure showing the example of 1 composition of the phase converter 310. This phase converter 310 is constituted by the four phase shift elements 320 as shown in drawing 3 (b), and it operates as a 4-bit phase converter. Spreading the electric wave emitted from the horn antenna 400 toward the direction 10 shown in drawing 3 (b), direction of the electric field in that case assumes that it is suitable in the direction 20 shown in drawing 3 (b). The phase shift element 320 is constituted by the liquid crystal 323 with which the rectangular parallelepiped cell surrounded by the conductor sheet metal 322 of 2 sets of dielectric thin plates [321 or 1 set of], the dielectric thin plates 321, and the electrode sheet metal 322 was filled up, and the path cord 324 as shown in drawing 3 (b).
[0004]The orientation direction of each molecule which constitutes the liquid crystal 323 with which it filled up in the phase converter 320 with the voltage impressed to the conductor sheet metal 322 via the path cord 324 is changeable. Here, it is known as anisotropy of a dielectric constant that a dielectric constant will change with the orientation directions of each molecule which constitutes a liquid crystal. Since a liquid crystal has anisotropy in a dielectric constant, by controlling the orientation direction of a molecule, it can change a dielectric constant and can change the propagation rate of the electric wave which passes through each phase converter 320. As a result, the operation as the lens antenna 300 is realizable by adjusting the propagation rate of the electric wave which passes through each phase shift element 320 which constitutes the phase converter 310 every phase shift element 320.
[0005]

[Problem(s) to be Solved by the Invention]Here, since the liquid crystal used for a lens antenna is a fluid, it is necessary to make the space filled up with a liquid crystal with a ceramic board, a metal plate, etc. And conventionally, the liquid crystal cell was constituted by the dielectric thin plates 321, the conductor sheet metal 322, and the liquid crystal 323, as shown in drawing 3 (b). And in order to control stably the orientation of the liquid crystal 323 in particular in order to control the orientation of the liquid crystal 323 stably, when not impressing voltage between the conductor sheet metal 322, thickness of the liquid crystal 323 must be made thin to about 100 micrometers or less.

[0006]On the other hand, since the conductor sheet metal 322 constitutes a liquid crystal cell, the mechanical strength of the grade which maintains the shape of a liquid crystal cell is called for. Therefore, the thickness of the conductor sheet metal 322 had to be not less than about 100 micrometers, for example. Or although using the thing which made dielectric thin plates vapor-deposit a conductor thin film instead of the conductor sheet metal 322 was also considered, the thickness of dielectric thin plates had to be not less than about 50 micrometers even in this case.

[0007]Since the rate of the area of a liquid crystal part over the effective area product of a lens antenna decreased, and the transmissivity of an electric wave decreased remarkably by the above restrictions and the rate of change of the dielectric constant of a lens antenna decreased, problems, like the control range of the direction of movement of an electric wave becomes narrow had arisen. In order to secure the control range of the transmissivity of an electric wave, or the direction of movement of an electric wave to some extent, it is required that thickness of the liquid crystal 323 should be made as thick as possible in about 100 micrometers or less. If thickness of the liquid crystal 323 is thickened with composition like before, the response of orientation change of the liquid crystal element to change of control voltage will become slow. As a result, the problem that the speed of response of control of a radio beam fell was also produced.

[0008]this invention is made in order to solve this problem, and it comes out. It is providing the lens antenna which the purpose's improves the transmissivity of **, and the control range of the direction of movement of an electric wave is extended, and can be improved in the speed of response of control of a radio beam.

[0009]

[Means for Solving the Problem]In consideration of the above point, an invention concerning claim 1 has the composition produced by laminating by turns a liquid crystal impregnating raw material produced by impregnating a predetermined raw material with a predetermined liquid crystal, and a predetermined electrode.

[0010]Since a necessary range is acquired as a control range of a direction of movement of an electric wave and size of a required lens antenna can be made small by this composition compared with the conventional lens antenna, the small weight saving of the lens antenna can be carried out, and it can form simply. By that which will become large compared with a lens antenna of the former [transmissivity / of a lens antenna] if a lens antenna of this invention is considered as some of transmitters or horn antenna **** radio beam sending sets (a loss of a lens antenna becomes small). Output power of a transmitter required in order to obtain desired transmission power can be made small, and a small weight saving of the whole device can be attained.

[0011]An invention concerning claim 2 has the composition in which said predetermined raw material contains paper, cloth, or textiles in claim 1. This composition can constitute a lens antenna using the usual material which can be easily impregnated with

a liquid crystal.
[0012]An invention concerning claim 3 has the composition containing a liquid crystal produced by said predetermined liquid crystal mixing a pneumatic liquid crystal, cholesteric liquid crystal, a smectic liquid crystal, or these liquid crystals in claim 1. By this composition, since a liquid crystal with the strong anisotropy of a dielectric constant is used, a smaller lens antenna is realizable.
[0013]
[Embodiment of the Invention]Hereafter, with reference to an accompanying drawing, the lens antenna concerning a 1st embodiment of this invention is explained. The typical composition of the lens antenna concerning a 1st embodiment of this invention is shown in drawing 1. The lens antenna 100 is constituted by the liquid crystal impregnating raw material 110, the 1st electrode 120, the 2nd electrode 130, and the control power source 140 in drawing 1 (a).
[0014]Each liquid crystal impregnating raw material 110 impregnates with a liquid crystal the raw material which can be impregnated with paper, cloth, and textiles and other liquid crystals. Here, the case where what has thin plate-like shape about 200 micrometers thick, for example is used is explained. The 1st electrode 120 and 2nd electrode 130 may be a thing of the film state made for the conductive raw material, for example, a metallic foil about 5 microns thick etc. may be sufficient as them.
[0015]The liquid crystal impregnating raw material 110 is accumulated by turns, as it is indicated in drawing 1 (a) as the 1st and 2nd electrode 120 and 130. Here, the 1st electrode 120 has composition repeated by turns, as it is indicated in drawing 1 (a) also as the 2nd electrode 130.
[0016]Below, let the portion sandwiched by the 2nd most near electrode 130 of two sheets shown in drawing 1 (b) be a liquid crystal cell layer. Here, this 2nd most near electrode 130 of two sheets shall be included in a liquid crystal cell layer. Therefore, it is also possible that the lens antenna 100 laminated the liquid crystal cell layer structurally, and the lens antenna 100 in case the number of laminations is n is shown in drawing 1 (a).
[0017]What makes the structure where the electrode which carried out strip-of-paper-like shape was arranged in the transverse direction for example, may be sufficient as the 1st electrode 120. Below, each of the electrode which carried out shape of the shape of this strip of paper is also called 1st electrode 120. In drawing 1 (a), the number of the electrodes which carried out shape of the shape of a strip of paper arranged in the transverse direction is made into m sheets. Therefore, the electrode which carried out strip-of-paper-like shape will be arranged nxm sheets on the whole. It is liquid crystal cell **** about the thing of the portion into which the electrode which carried out shape of the shape of one strip of paper among liquid crystal cell layers is inserted by the 2nd electrode 130 below as shown in drawing 1 (b). Here, the 2nd electrode 130 of two sheets that sandwiches the liquid crystal impregnating raw material 110 shall be included in a liquid crystal cell.
[0018]Next, the control power source 140 is connected between the 1st electrode 120 of each liquid crystal cell, and the 2nd electrode 130. Here, the 2nd electrode 130 has predetermined reference potentials, such as a ground, and has composition which controls the potential of the 1st electrode 120 by the control power source 140.
[0019]Operation of a liquid crystal cell is explained using drawing 2. The orientation direction of a liquid crystal when voltage is not impressed between the 1st electrode 120 and the 2nd electrode 130 is shown in drawing 2 (a). Here, the example in which the molecule 111 which constitutes a liquid crystal is arranged in general in parallel to the electrode is shown.

[0020]Next, if predetermined voltage is impressed by the control power source 140, the molecule 111 which constitutes a liquid crystal as shown in drawing 2 (b) is constituted so that it may become in general vertical to the 1st electrode 120 and the 2nd electrode 130 and orientation may be carried out. Thus, the liquid crystal cell has the composition that the orientation direction of a liquid crystal element can change and the dielectric constant of the liquid crystal impregnating raw material 110 can be changed, if predetermined voltage is impressed between the 1st electrode 120 and the 2nd electrode 130. And by adjusting the dielectric constant of each liquid crystal cell, the lens antenna 100 becomes possible [adjusting distribution of the dielectric constant in the lens antenna 100], and can control the direction of a radio beam.
[0021]Here, an example of the rate of the area of the liquid crystal layer portion occupied to a lens antenna effective area product using the numerical value of the thickness of the thickness of the liquid crystal impregnating raw material 110 illustrated in the above, the 1st electrode 120, and the 2nd electrode 130 is computed. The computed value will be 97% (=200/(200+5)), and as compared with the lens antenna of conventional technology, it can reduce also tens of%, and the decrement of the transmissivity by a metallic foil is made to such an extent that it can almost be disregarded. Since this secured mechanical intensity to one only for the liquid crystal impregnating raw material 110 by using the liquid crystal impregnating raw material 110, it depends an electrode on the ability to have done thinly.
[0022]Since a large change of the dielectric constant as the whole lens antenna can also be taken, the control range of the direction of movement of a radio beam can be extended. If it puts in another way, size of a lens antenna required in order to acquire the necessary beam control range can be made small. Simultaneously, speed of response of radio beam control can also be made quick.
[0023]The liquid crystal impregnated with the liquid crystal impregnating raw material 110 has the anisotropy of a dielectric constant to high frequency here, and the dielectric constant of the long and slender major axis direction of a liquid crystal element is high compared with the thing of the direction of a minor axis. Since the larger one can control a phase shift greatly, the liquid crystal mixture of a pneumatic liquid crystal with the big anisotropy of a dielectric constant, cholesteric liquid crystal, a smectic liquid crystal, or these liquid crystals can be used for the anisotropy of the dielectric constant as a liquid crystal impregnated with the liquid crystal impregnating raw material 110.
[0024]However, in order to acquire rapidity, the pneumatic liquid crystal of low viscosity and high elasticity is suitable. In particular, the pneumatic liquid crystal of a refractive index anisotropy big cyano-biphenyls system, a terphenyl system, a pyridine system, a pyrimidine system, and a tolan series is preferred. The ferroelectric liquid crystal which has spontaneous polarization and shows a high speed response on the other hand in using a smectic liquid crystal is useful. The material and structure where the loss in a high frequency region can contain more liquid crystals few as a raw material impregnated with such a liquid crystal are effective.
[0025]As explained above, since size of a lens antenna required in order to acquire the necessary range as a control range of the direction of movement of an electric wave can be made small compared with the conventional lens antenna, the small weight saving of the lens antenna can be carried out, and the lens antenna concerning a 1st embodiment of this invention can be formed simply.
[0026]By that which will become large compared with the lens antenna of the former [transmissivity / of a lens antenna] if the lens antenna of this invention is considered as some of transmitters or horn antenna **** radio beam sending sets (the loss of a lens

antenna becomes small). The output power of a transmitter required in order to obtain desired transmission power can be made small, and the small weight saving of the whole device can be attained. Since the speed of response of radio beam control becomes high-speed, an application range can be extended also to the device which needs high-speed beam control like a radar, for example.

[0027]

[Effect of the Invention]As explained above, this invention can improve the transmissivity of an incident radio wave, the control range of the direction of movement of an electric wave can be extended, and the lens antenna which can be improved in the speed of response of control of a radio beam can be realized.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1]A lens antenna obtaining by laminating by turns a liquid crystal impregnating raw material produced by impregnating a predetermined raw material with a predetermined liquid crystal, and a predetermined electrode.
[Claim 2]The lens antenna according to claim 1, wherein said predetermined raw material contains paper, cloth, or textiles.
[Claim 3]The lens antenna according to claim 1, wherein said predetermined liquid crystal contains a liquid crystal produced by mixing a pneumatic liquid crystal, cholesteric liquid crystal, a smectic liquid crystal, or these liquid crystals.

[Translation done.]

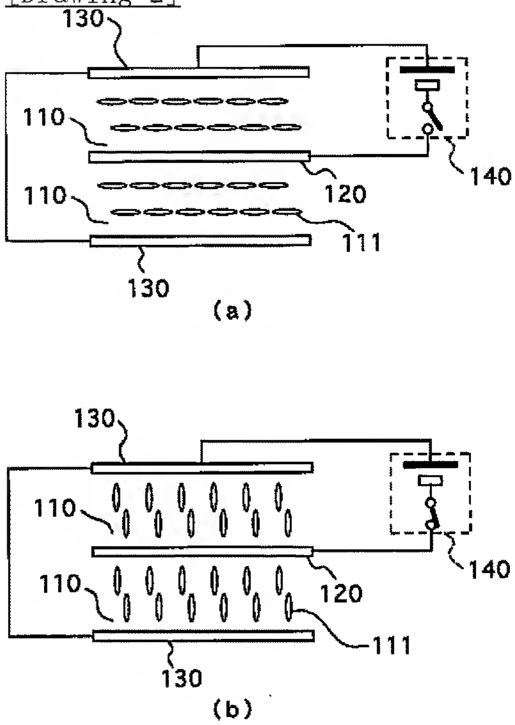
* NOTICES *

JPO and INPIT are not responsible for any damages caused by the use of this translation.

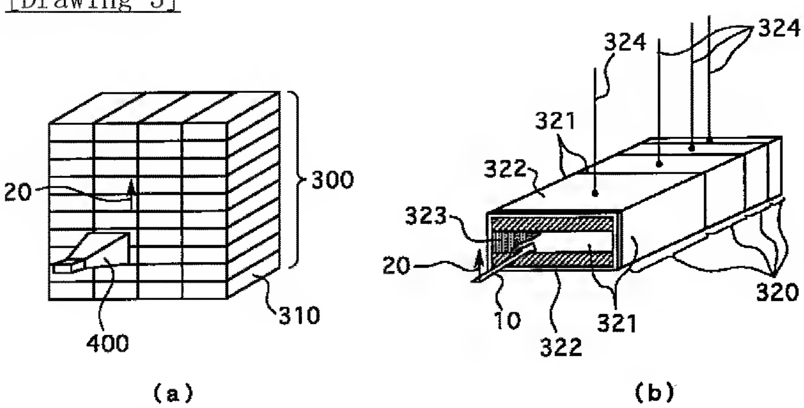
1. This document has been translated by computer. So the translation may not reflect the original precisely.
2. **** shows the word which can not be translated.
3. In the drawings, any words are not translated.

DRAWINGS

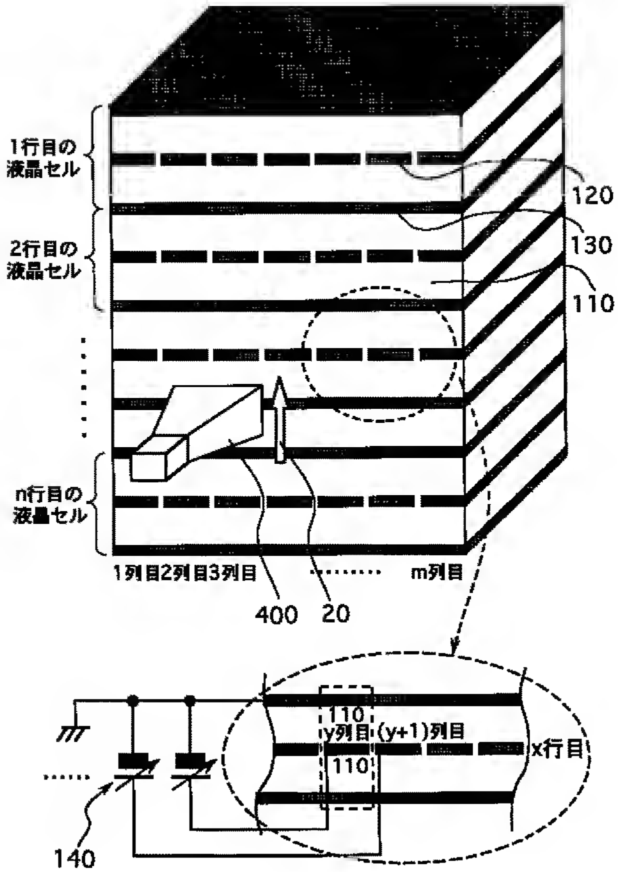
[Drawing 2]



[Drawing 3]



[Drawing 1]



[Translation done.]